

Assessing the Leachability of Reclaimed Wastewater Contaminants

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Water Branch

Project Organization

- Managed & funded by HDOH, Safe Drinking Water Branch under the Groundwater Protection Program
- Research is being done by the University of Hawaii, Dept. of Civil Engineering
 - Dr. Chittaranjan Ray, Lead Principal Investigator
 - Dr. Matteo D'Alessio, Soil and Chemical Researcher
 - Dr. Seojin Ki, GIS Modeler

The Research Question

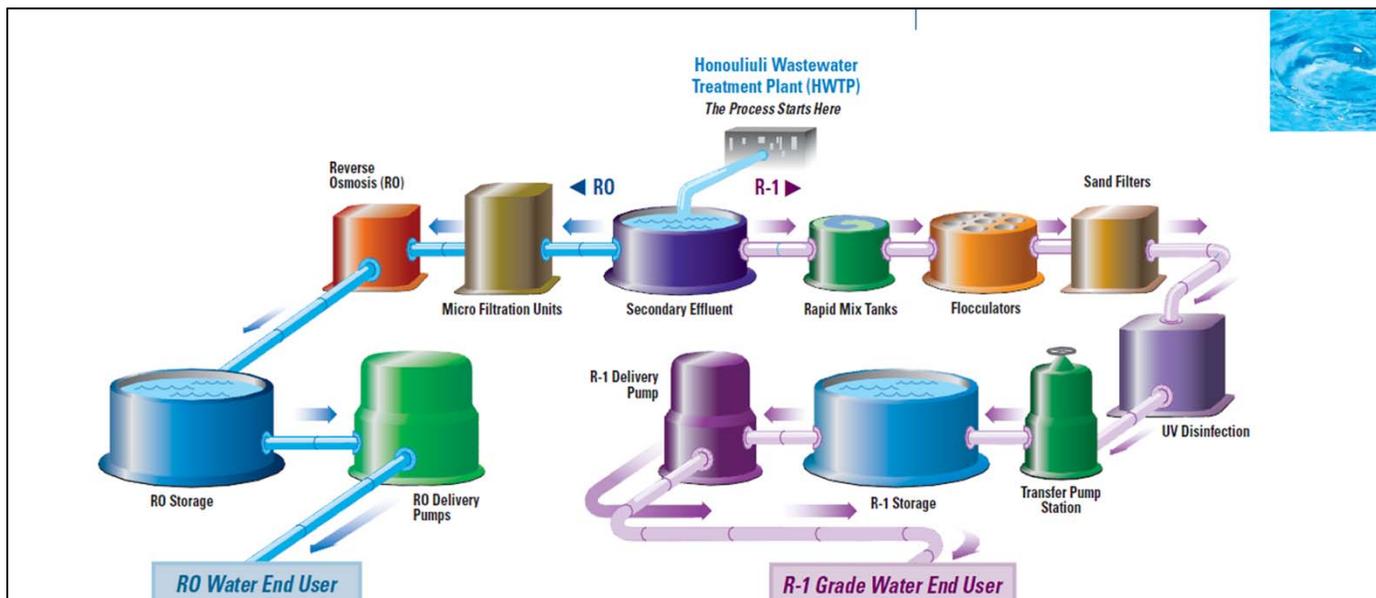
- What changes in groundwater quality may result from the use of reclaimed wastewater?
 1. What contaminants are removed by conversion of sewage to R1 quality water?
 2. What role does Hawaii soil play in removal or retardation of the remaining contaminants?
 3. Which contaminants are most likely to migrate to the groundwater?
 4. What areas in Hawaii are the most suitable for application of reclaimed wastewater?

How Are Questions to be Answered?

1. Do pre- and post-treatment chemical analysis of wastewater of selected wastewater contaminants.
2. Sample a wide range of Hawaii soils and evaluate their chemical transport characteristics
3. Conduct experiments to characterize the interaction between the soil and selected wastewater contaminants
4. Populate a leaching assessment model to map the relative leaching risk of wastewater contaminants

What Role Does Treatment Play in Contaminant Removal?

- Treatment
 - Primary Treatment (solids removal)
 - Secondary (e.g. aeration)
 - Reuse treatment (e.g. advanced filtration, membrane reactors, disinfection)
 - Low removal rates for some wastewater contaminants



Wastewater Sample Collection

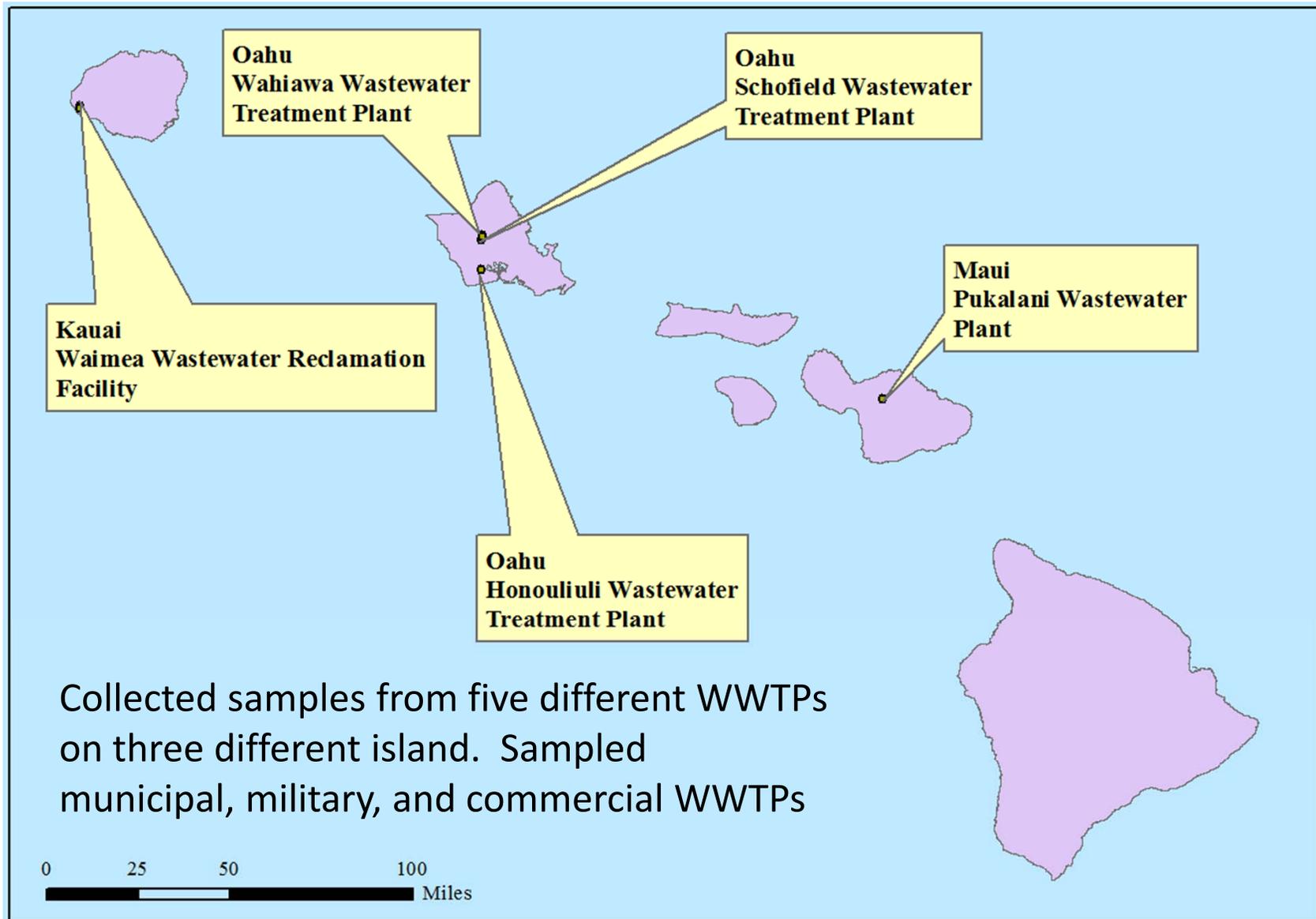


Collected samples prior to treatment to characterize bulk sewage chemistry

Collected samples of R-1 water to evaluate the effectiveness of the treatment process in removing contaminants



Wastewater Sample Locations



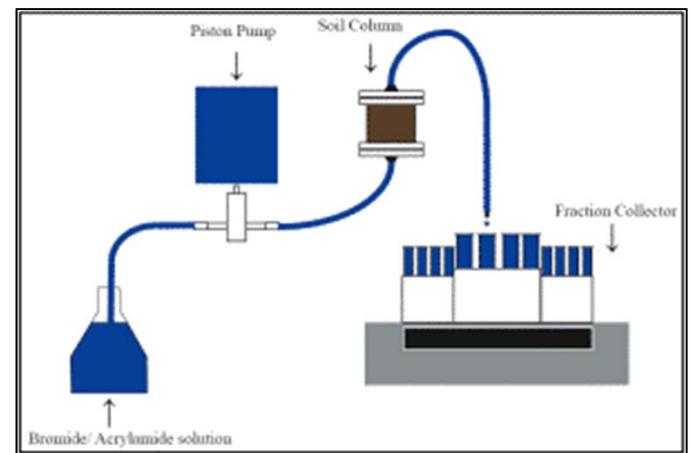
Analyze for Representative Wastewater Contaminant Compounds

- Analytes
 - Estrone
 - 17-beta estradiol
 - estriol
 - Caffeine
 - Phenazone,
 - Gemfibrozil
 - cotinine

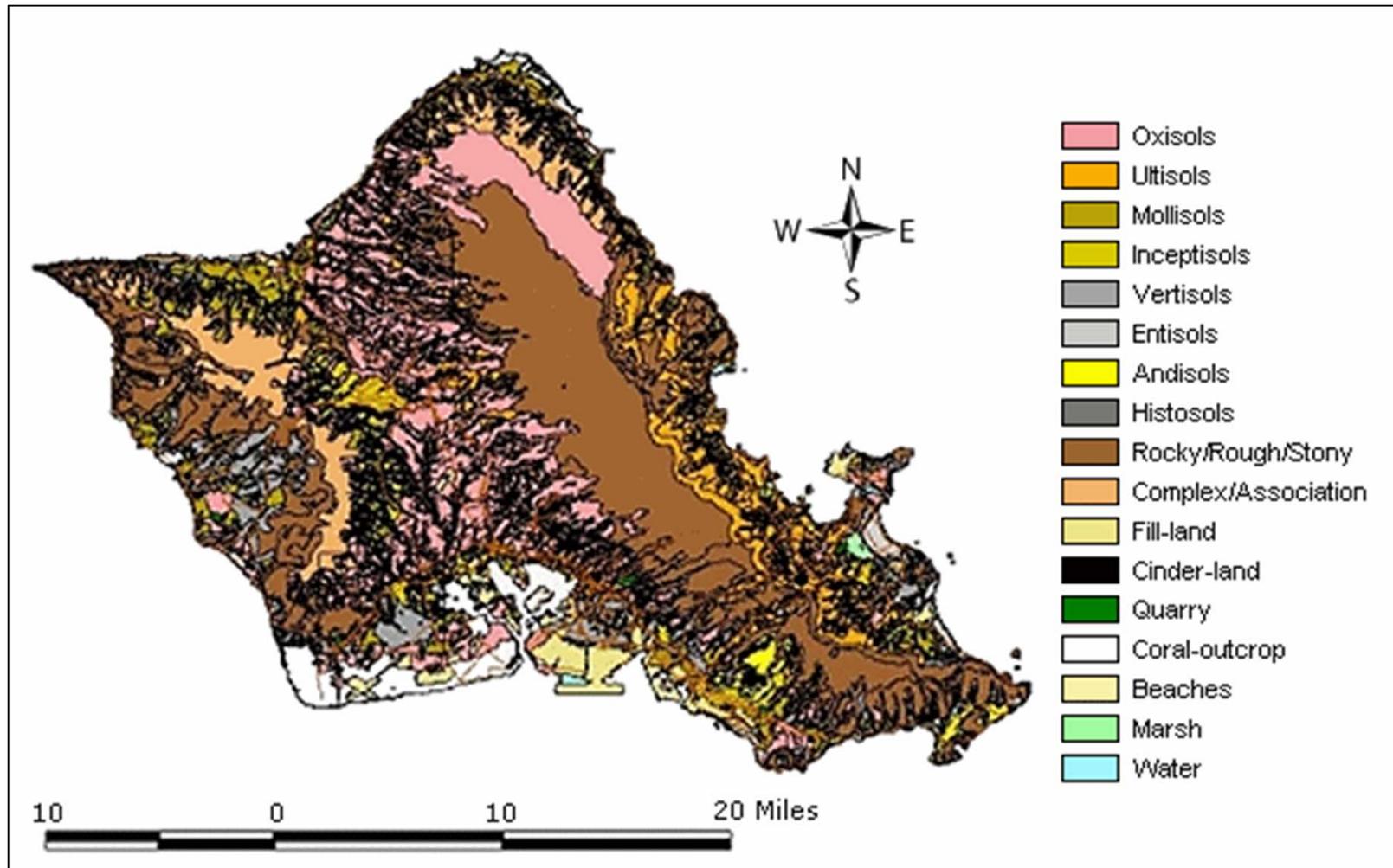


Characterize the Role of Hawaii Soils in Fate and Transport of Contaminants

- Perform hydraulic tests on soil
- Characterize the interaction between selected contaminants and various Hawaii soils



Hawaii Soils - Diverse Characteristics

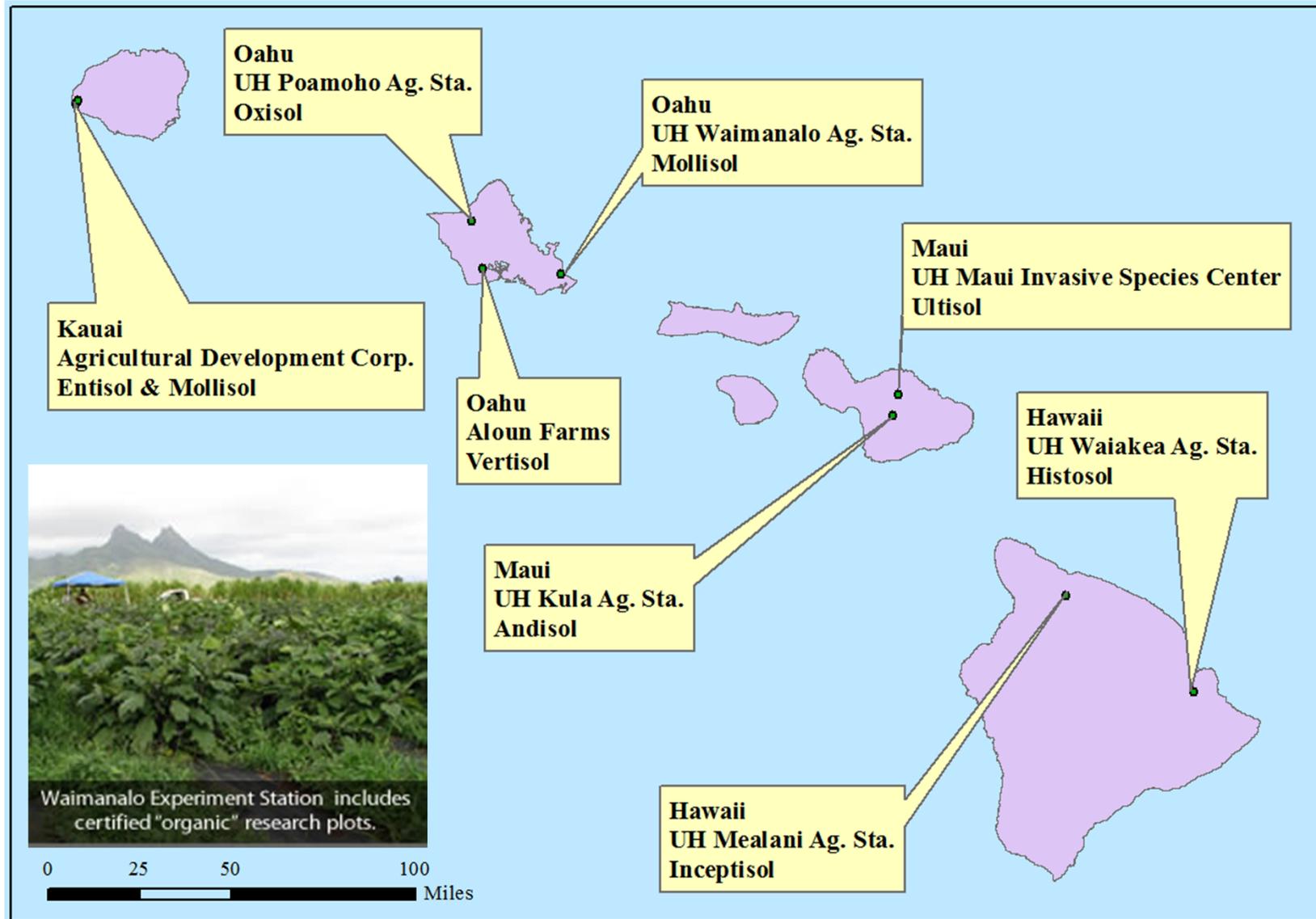


Soil order is the top tier of the taxonomy hierarchy

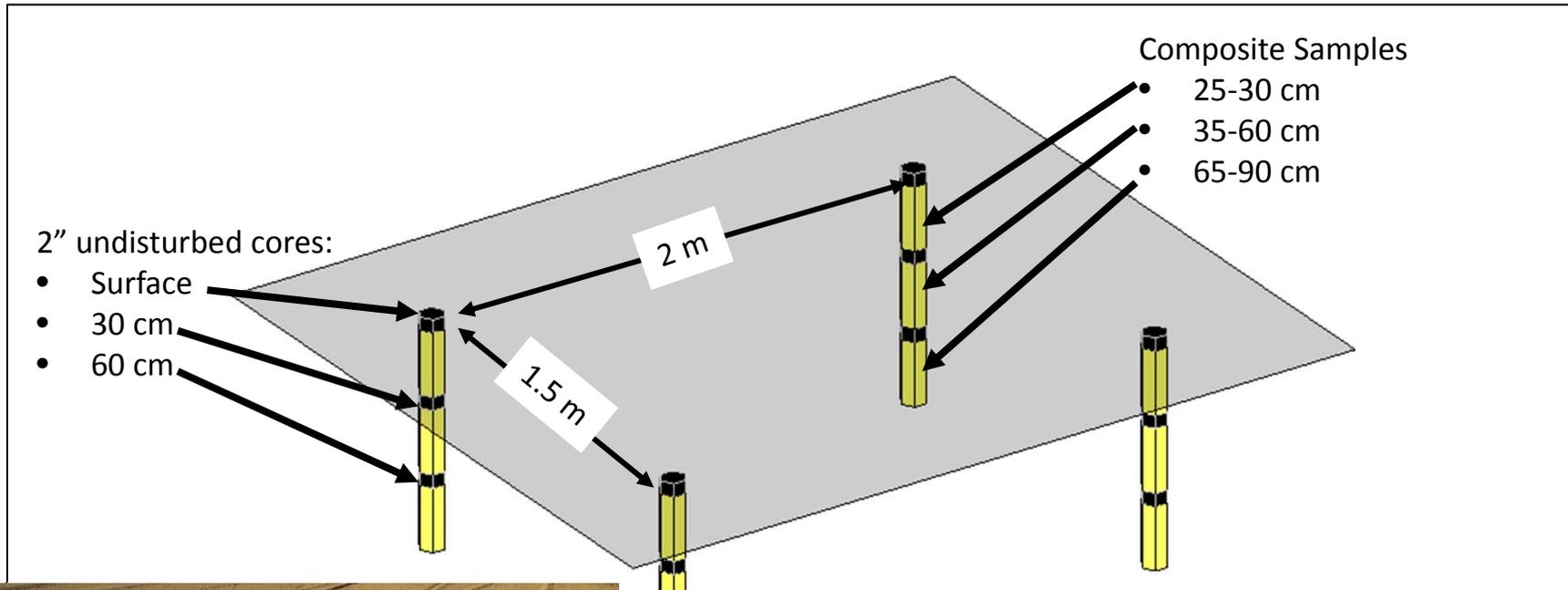
Hawaii has ten of the twelve soil orders in the soil taxonomy

Soil series (~190 in Hawaii) is the lowest in taxonomy hierarchy

Collected specimens Representing eight of the ten orders
Most samples collected from UH Experiment Stations

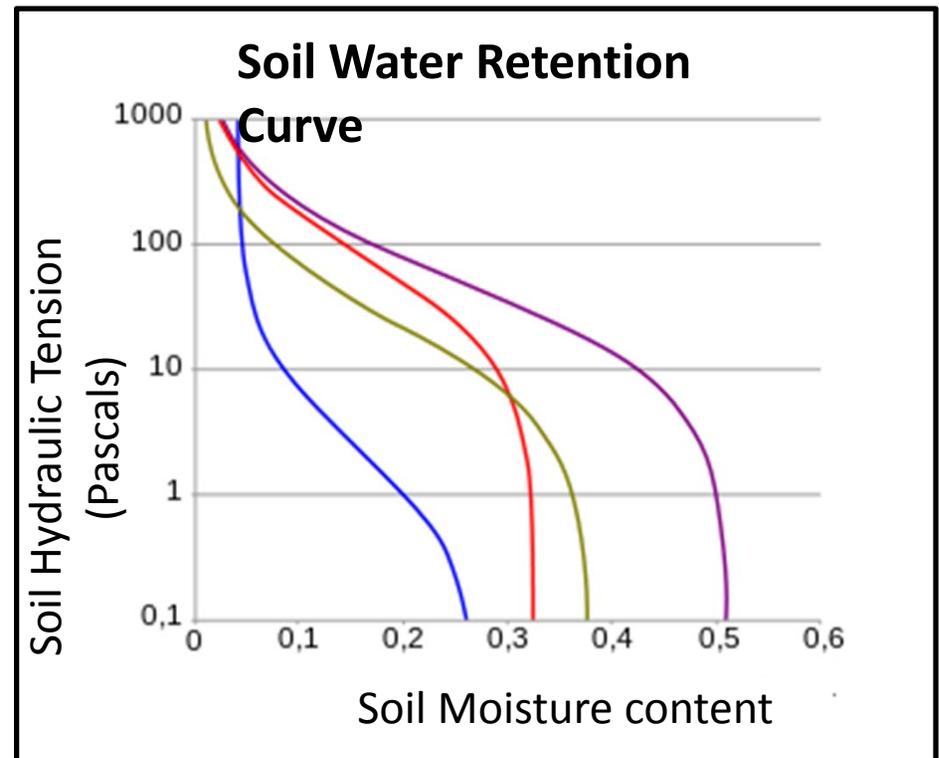


Soil Sample Collection



Characterize the Soil's Water Transmission and Chemical Retention Properties

- Soil Parameters
 - Bulk density
 - Field capacity
 - water retention curve $h(\theta)$
 - Fraction organic carbon



Evaluate Transport Characteristics of Wastewater Contaminants in Soil

- Batch studies
 - Sorption - Evaluate the affinity of pharmaceuticals to attach to soil grains
- Degradation
 - The natural breakdown of the pharmaceutical compounds due to chemical and biological activity
 - 60 day degradation test

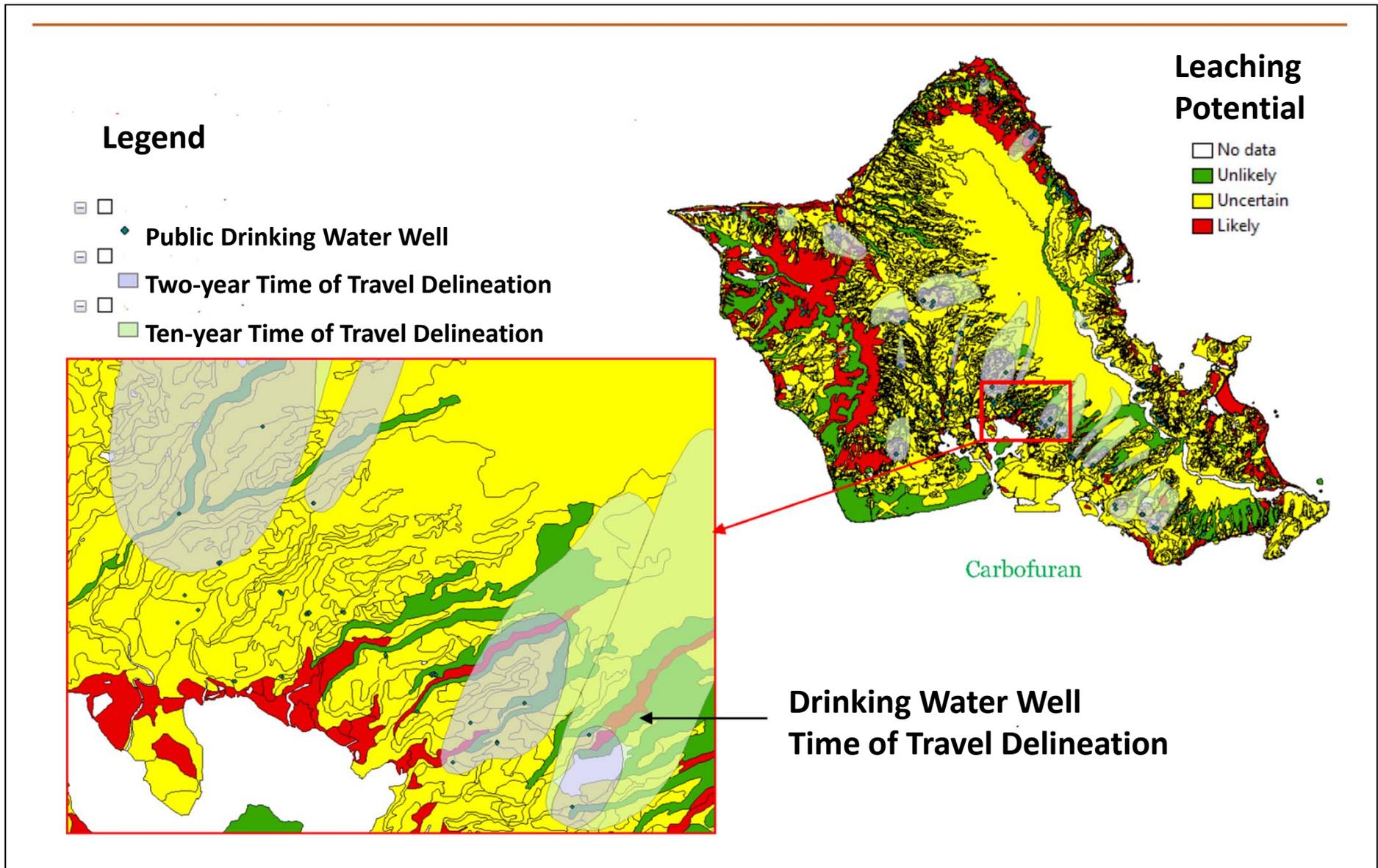


Use the Test Results to Model the
Leaching Potential of Wastewater
Contaminants

Comprehensive Leaching Risk Assessment System (CLEARs)

- Comprehensive Leaching Risk Assessment System (CLEARs)
- GIS based leaching assessment model
- Developed by UH – Dept. of Civil Eng. To evaluate pesticide leaching prior to licensing
- Expanded to include
 - Volatile contaminants
 - And now wastewater contaminants
- Inputs
 - Recharge
 - Soil hydraulic and chemical characteristics
 - Contaminant fate and transport characteristics
- Output
 - Potential for a contaminant to leach to the groundwater

CLEARs Modeled Leaching Potential for the Pesticide Carbofuran



Reclaimed Wastewater and Groundwater

- Will the use of reclaimed wastewater have a detectable impact on groundwater?
 - Likely “Yes” (2000 NAQWA Study [Hunt, 2003])
- Will this impact be unprecedented?
 - Likely “No” since we currently “apply” up to 70 mgd of wastewater in the form of on-site sewage disposal
- Will this study be the “final word”?
 - Likely “No” since field verification is desirable and the list of wastewater contaminants is very long
 - This study WILL provide valuable insight to be considered in reclaimed wastewater planning process

Thank You!